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Science

Science

Earth Science

Orbiting the Sun



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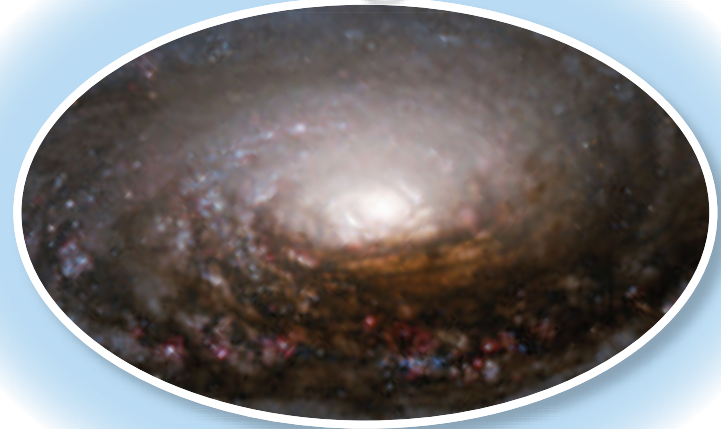


by Donna Latham





Orbiting the Sun



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Earth's Journey

Do you realize that right now you are moving at the incredible speed of 107,000 kilometers per hour (66,000 miles per hour)? It's true. You can't feel it, but at this very moment Earth is orbiting, or moving in a path, around the sun. Earth is not alone in this journey. In fact, eight other spherical, or ball-shaped, planets circle the sun too.

You probably know that the sun, Earth, and other planets make up our solar system. Smaller orbiting objects—such as comets, meteors, and asteroids—are parts of the solar system too.

You're also probably familiar with Earth's orbit, or path, around the sun. But people were not always aware of Earth's journey. It was only through the work of early **astronomers** from long ago that people learned about the true nature of the solar system. Let's explore their discoveries.

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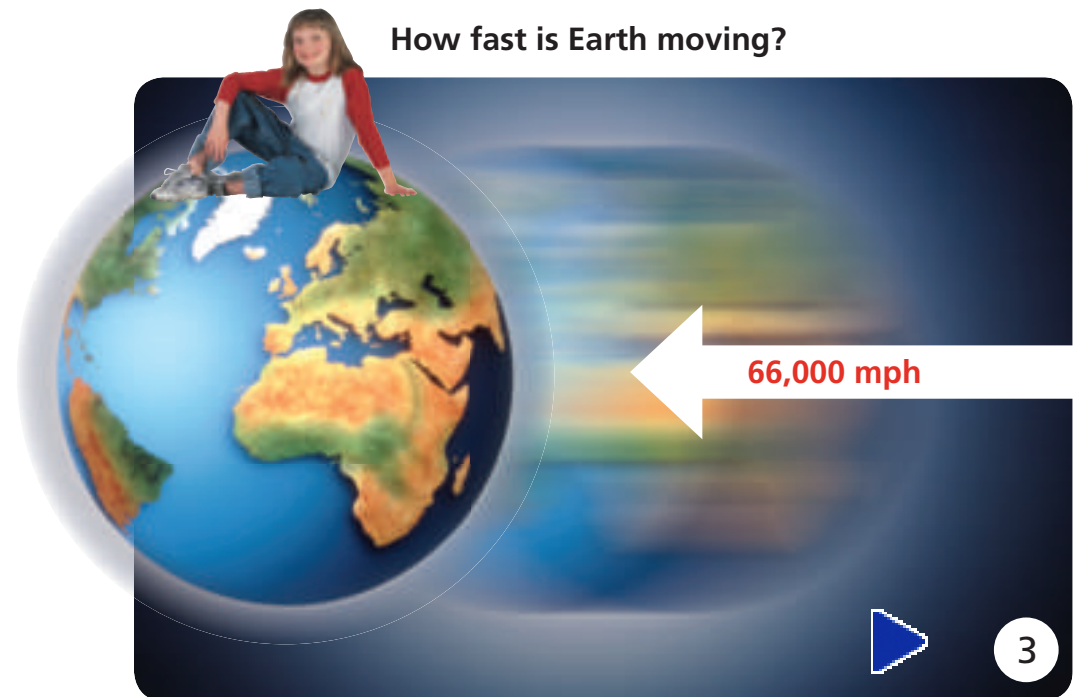
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Astronomy

Astronomy is the study of planets, stars, and other objects in space. This science began in ancient times. In fact, many old tales from around the world are stories about space. Greek and Roman mythology tell of the planets and stars.

People in ancient times relied on myths to explain the natural world. Such stories offered an explanation for mysteries such as why the sun seemed to move. Other stories explained constellations. They explained why **brilliant** stars appeared in certain patterns.

Ancient people used characters to represent or symbolize objects in the sky. For example, ancient Greeks named the god of the sun Helios. According to their myths, Helios drove a golden chariot of fire through the sky.



Some Native American stories told of the sun and moon. In them, the sun and moon were brother and sister.

The ancient Romans believed there was a moon goddess named Luna. Did you know that the word *lunar*, which means “having to do with the moon,” comes from Luna’s name?

Through their tales and stories, ancient people tried to make sense of the world around them. Because ancient people did not have the knowledge we have about space, they depended on these tales and stories. Through their tellings, they were able to offer ideas of what **shimmering** stars were, or why the moon that **gleamed** above them did not look the same every night.

But in time, ancient astronomers began to form new ideas based on scientific observations. Let’s look at the sky through their eyes!



Helios’s chariot rode from east to west through the sky.



Ancient Greek temple





Ancient Astronomers

An astronomer is someone who studies space and its heavenly bodies. Today, astronomers depend on high-tech tools to do their jobs. Space probes visit other planets to collect and bring back data for astronomers on Earth to study.

Satellite images from space help astronomers too. Powerful telescopes allow them to see what can't be seen with the eye alone. In ancient times, however, these scientific tools were not available. Without the high-tech tools available today, how did ancient astronomers study space? They did it with the amazing tools available at that time—their eyes!

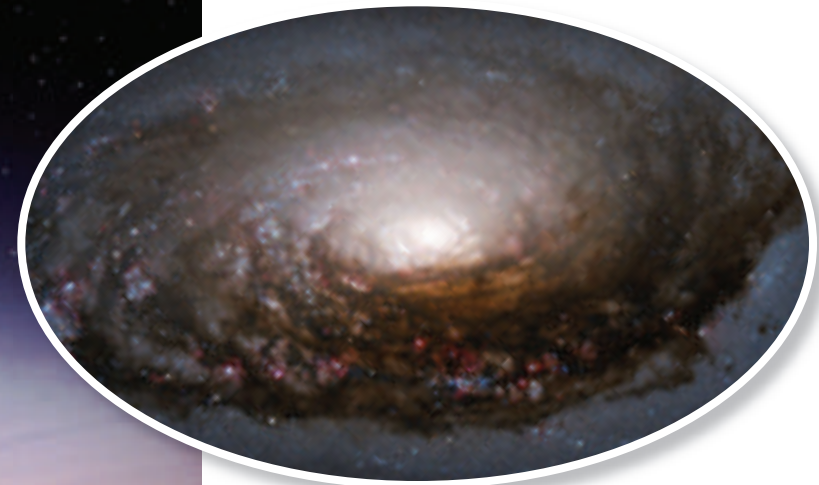


The next time you look at the night sky with just your eyes, remember that you are like an astronomer of long ago.



By watching the sky, ancient people recognized that the sun, moon, and planets move. With the facts we have available today, we know this takes place because Earth and the other planets orbit the sun, and the moon orbits Earth. A scientist named Isaac Newton discovered three rules, or laws of motion, about how and why objects move. Today, scientists are aware of these laws of motion, and they know that everything in the universe is always moving. Remember, Earth is moving right now, as it orbits the sun.

Today's scientists are also aware of the force of gravity. As you might know, this force causes the planets to move. In the past, people did not know the importance of gravity. So they came up with guesses to explain why there was movement in the sky. Have you ever guessed before? Then you probably know that guesses are not always correct!



Astronomers today use data from satellites orbiting in space to study distant galaxies.





Earth-Centered Ideas

Pythagoras (580?–500? B.C.)

Pythagoras lived in ancient Greece. A mathematician and thinker, he was convinced that Earth was round and at the center of the universe. Pythagoras believed that the sun, moon, and other planets, as well as Earth, moved.

Aristotle (384–322 B.C.)

Aristotle, an important thinker, teacher, and scientist, also lived in ancient Greece. He studied science, collecting valuable information about plant and animal life. He came up with the idea that the universe was shaped like a circle. In the very center, he claimed, was Earth. He believed that Earth was stationary, or did not move. It would be a very long time before Aristotle's ideas were challenged. In fact, they would not be checked until the 1600s.

Ptolemy (A.D. 100?–165?)

The ancient Greek astronomer Ptolemy developed his own ideas. He believed that Earth was round but did not move. Instead, the sun, moon, and stars all moved around Earth. Each moved in a little circle, which he called an epicycle, around a bigger circle.



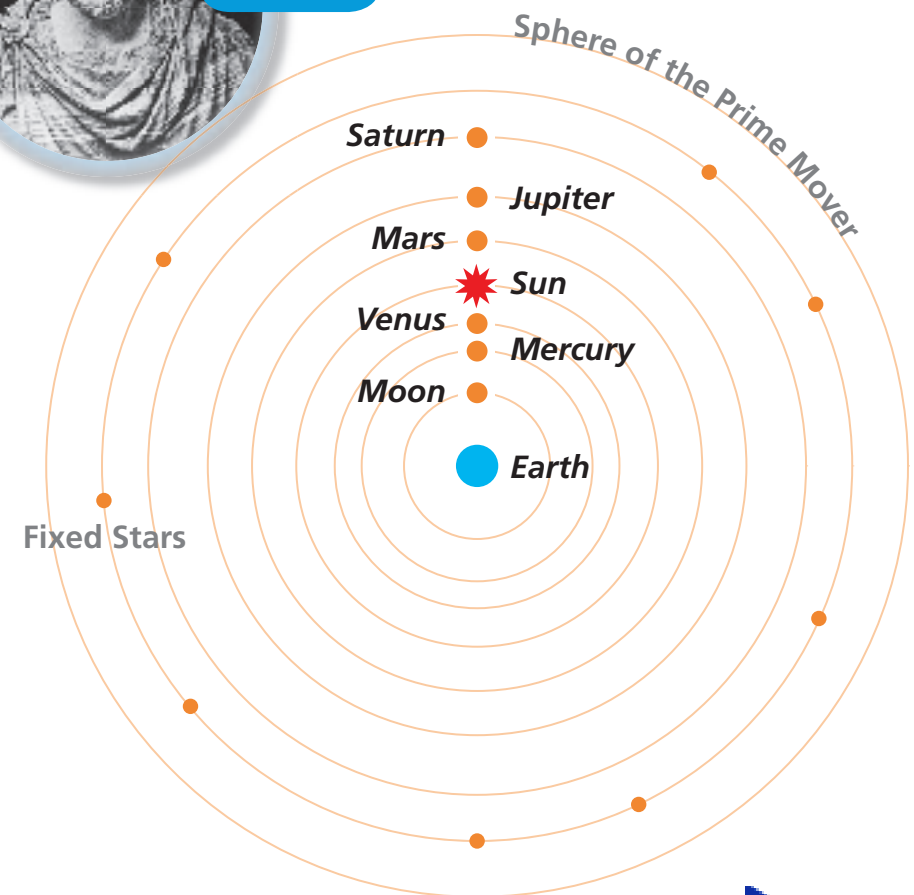
Aristotle's Universe

This diagram shows the universe as Aristotle envisioned it. Notice that it is round. In the center of the universe is Earth. Around it are the planets that can be seen with the eye alone. These are Mercury, Venus, Mars, Jupiter, and Saturn.

Where are Uranus, Neptune, and Pluto? Those are the outer planets, which can only be seen through a telescope. They had not been discovered yet.



Aristotle





Sun-Centered Ideas

You have read about several ancient Greek astronomers' beliefs. They each had different ideas about whether Earth moved, but all viewed Earth as the center of the universe. It was not until almost fourteen hundred years later that a new thinker challenged those ideas, switching the places of Earth and the sun.

Copernicus (1473–1543)

Today, we consider the Polish astronomer Nicolaus Copernicus to be the father of astronomy. Most people who lived during Copernicus's lifetime believed Ptolemy's ideas. A chorus of voices proclaimed that Earth was the center of the universe and did not move.

But Copernicus disagreed. He thought Ptolemy's ideas were too complex. He was certain that a much simpler explanation existed. Earth, Copernicus claimed, moved, but it wasn't the only moving object in the sky. Instead, the moon and all the planets traveled around the sun too.

Copernicus had a theory based on the idea that Earth rotated on an axis. This movement, he said, caused other bodies in space to seem to move too. In 1543, he published a book called *On the Revolutions of the Celestial Spheres*. In it he laid out his theories, but they still had to be proved.

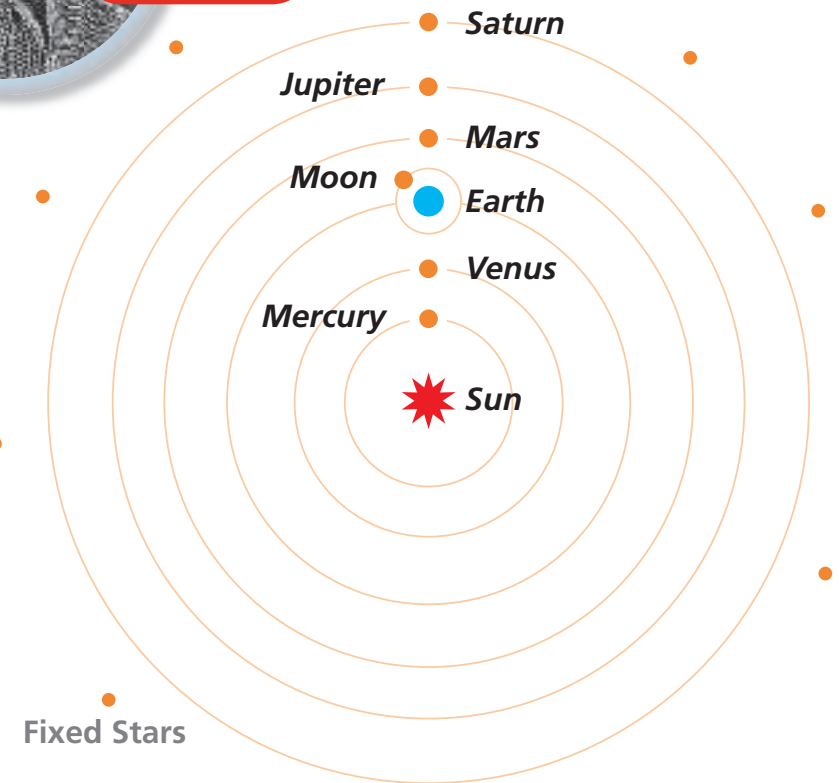


The diagram below depicts the universe as Copernicus visualized it. Earth is no longer at the center. Copernicus's ideas were heliocentric, or sun-centered. Compare this diagram with Aristotle's, and note how the sun and Earth have switched places.

In Copernicus's universe, Uranus, Neptune, and Pluto are still missing. Even fourteen hundred years after Aristotle, these distant planets remained unknown.



Copernicus





Galileo (1564–1642)

Galileo's Ideas

Galileo Galilei, now simply known as Galileo, was born in Pisa, Italy. With a gift for mathematics, he worked first as a tutor and then as a professor. As Galileo planned the lessons that would help his students learn, he kept learning himself. Galileo studied Aristotle and questioned his ideas about space. Later, when Galileo taught astronomy courses, he questioned Ptolemy's ideas too. Galileo doubted Ptolemy's Earth-centered views of the solar system.

As time went on, Galileo learned more and more about astronomy. In 1592, he became a professor at an Italian university. By then, he was fairly certain that Ptolemy's ideas were not right. Instead, Galileo believed that Copernicus's sun-centered views were correct.

The Telescope

No one is certain who invented the telescope, but we do know that people experimented with lenses in the 1500s and 1600s. Hans Lippershey was a Dutch optician, who created lenses for eyeglasses. Lippershey is usually credited with inventing the first refracting telescope in 1608.

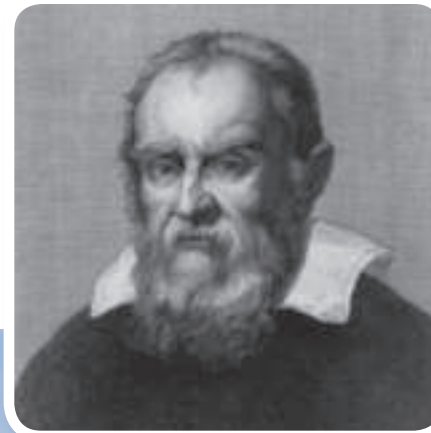
Just a year later, in 1609, Galileo made a telescope of his own. The world of astronomy was about to change.



Galileo's Telescope

Once Galileo had his homemade telescope, he aimed it at the sky. Now he was able to test Aristotle's and Ptolemy's ideas. He proved that they were incorrect.

Galileo wasn't always easy to get along with. Known for both his biting sense of humor and his strong opinions, he was no **coward**. Though his ideas were not always popular, he was never afraid to voice them.



Galileo was not the first person to invent a telescope, but he was the first to use it to observe the sky.





How Does a Telescope Work?

Have you ever looked at the night sky through a telescope? As you probably know, a telescope is a tool used to make distant objects appear closer and larger. It allows us to view faraway objects in space that cannot be seen with our eyes alone.

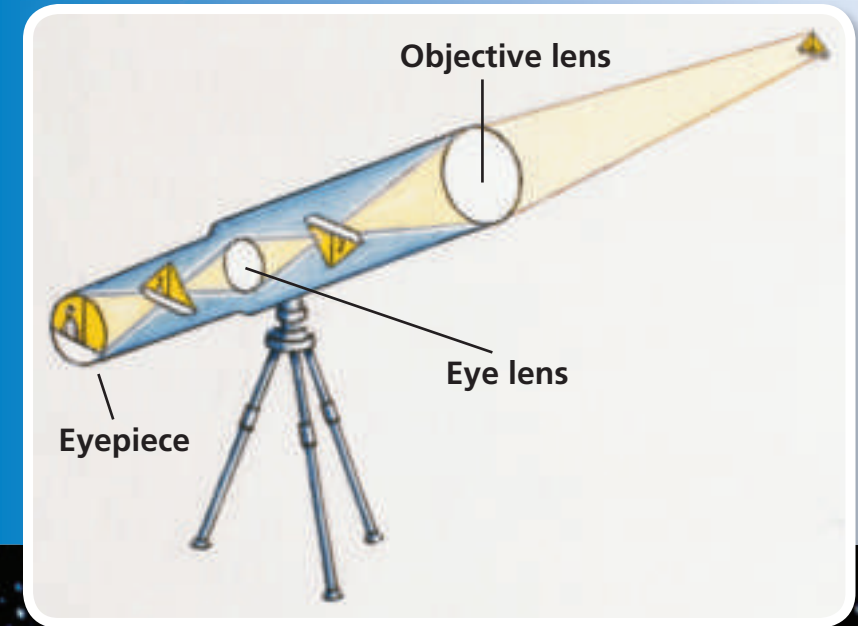
While telescopes today can be enormous and high-tech, Galileo's was hand-held and homemade. To examine the skies, he used a refracting telescope.

A refracting telescope has two lenses. One lens is called the objective lens. The other, at the eyepiece, is called the eye lens. Though both lenses magnify, more is done by the larger objective lens, as it takes in and focuses light. A refracting telescope magnifies the object being viewed, making it many times larger for close examination.

Both Aristotle and Ptolemy believed that the moon had a smooth surface. Remember, they had only seen the moon with their eyes. Now, with the telescope, Galileo had a tool that had not existed in ancient Greece. He would be the first to use it to get a better view of the moon.



A Refracting Telescope





The Surface of the Moon

Galileo made a major discovery about the moon in November of 1609. By studying the moon through his telescope, he learned that Aristotle and Ptolemy were not correct—the moon was not smooth, as they had claimed. Instead, its surface was pitted and full of craters. The surface of the moon also had flatlands, valleys, and mountains like Earth.

Galileo studied the moon, drawing sketches of its changes. During his observations, he noted that its light parts seemed to point away from the sun, and its dark parts seemed to point toward it. He believed that the dark sections were really shadows. As the sun fell on mountains and valleys, small shadows were cast that did not have the same appearance every night.

What did this mean? Galileo believed it meant that the moon was moving around the sun. As the moon moved, its position toward the sun changed causing the shadows to look different. Today, we know that the moon actually revolves around Earth.

People did not approve of Galileo's views at the time, but he stood his ground and paved the way for future theories.



The changes in the moon's appearance are called the phases of the moon. Over the course of a month, the moon appears to change shape. Its form ranges from a very narrow slice, or crescent, to a full sphere.

During its orbit, the moon reflects different amounts of sunlight. The part of the moon we see depends on how much of that reflection we see on Earth. This creates the illusion that the moon changes shape.



Phases of the Moon





Saturn's Rings

With his telescope, Galileo also observed Saturn, the second largest planet. Earlier in the year 1610, he discovered Saturn's rings, but Galileo was not certain what the rings were. Using only a small telescope, he couldn't see them very well. At first, he called them ears. He thought they might be **satellites**, or objects that revolve around a planet.

Today, we know that there are seven rings around Saturn, and that they are made of billions of pieces of rock, dust, and ice. Orbiting at Saturn's equator, the rings make Saturn one of the most breathtaking sights in the night sky.

The Cassini Spacecraft

Science has come a long way since the discovery of Saturn and its rings. We have sent astronauts into space and, in 1969, astronauts landed on the moon. Scientists' fascination with Saturn, however, has remained. On October 15, 1997, the National Aeronautics and Space Administration (NASA) sent the Cassini spacecraft into space. Cassini traveled an incredible 1.5 billion kilometers (934 million miles) to reach its destination. Finally, in the summer of 2004, Cassini began to travel around Saturn, in an opening in the icy rings.



This is a computer-generated image of the Cassini spacecraft on its mission.



With that move, it became the first spacecraft to join in Saturn's orbit around the sun. During its exploration, Cassini studied Saturn's atmosphere and discovered more about Saturn's rings. Cassini also sent back wonderful images for study on Earth.



Image of Saturn taken by the Cassini spacecraft





The Moons of Jupiter

In January of 1610, Galileo made another discovery. While observing Jupiter, the largest planet, he saw what he thought were three stars around it. He continued watching the planet for a week, and when another star appeared one night, he was puzzled. He wondered whether they were stars at all, or perhaps other planets or satellites. Galileo's persistent questions got him closer to proving his ideas about the solar system. Today, we call these four satellites the Galilean Satellites. These four large moons are known as Io, Europa, Ganymede, and Callisto.

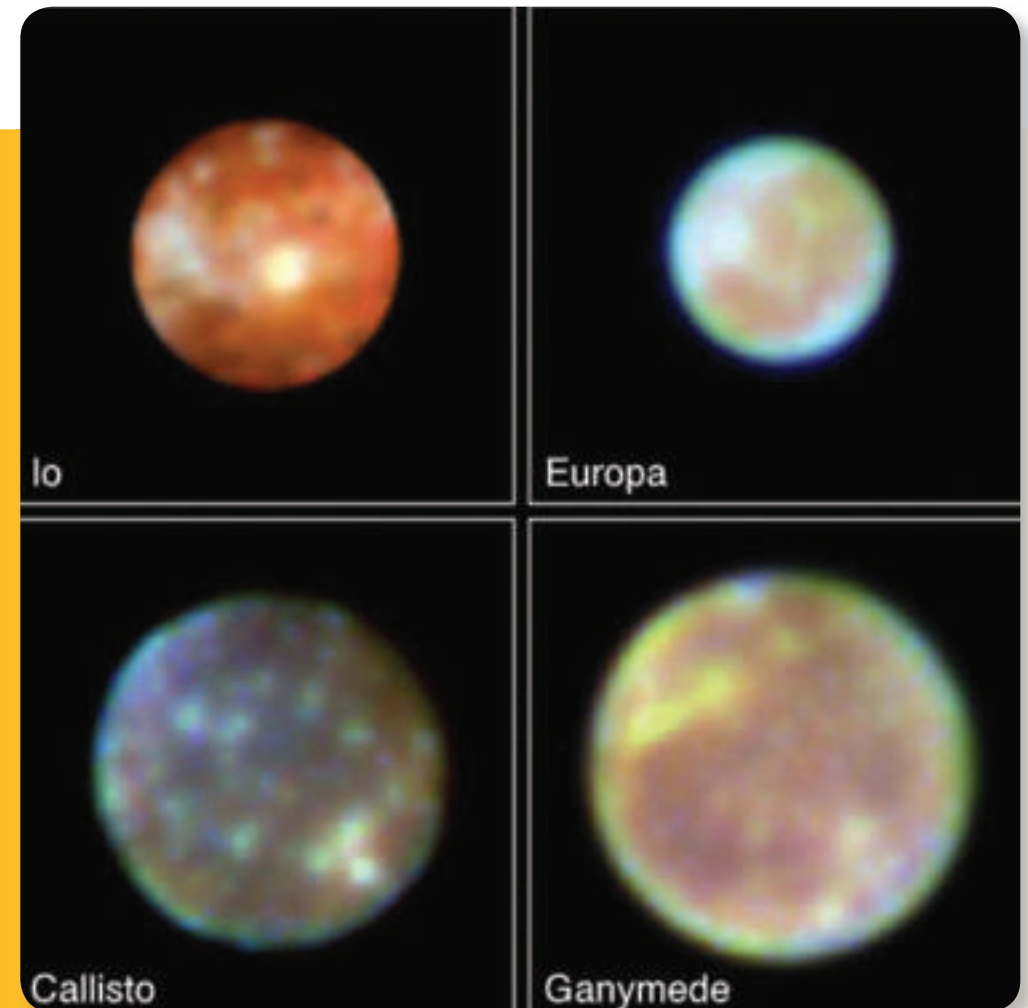
We now know that Jupiter has sixteen major satellites, along with many smaller ones. And that's not all we know. We are certain that Copernicus and Galileo were right—the moon, Earth, and the other planets do revolve around the sun.

We have Galileo to thank for paving the path to our knowledge of the solar system. His use of the telescope cleared the way for continuing discoveries and technologies. We greatly value his discoveries about the solar system, and we remember his strong beliefs in science and its use in testing ideas.



These images of the Galilean Satellites were taken by the Hubble Telescope. The Hubble Telescope, which is 595 kilometers (370 miles) above Earth, produces images that are remarkably clear and detailed.

Using his own small homemade telescope, Galileo had discovered these satellites about four hundred years ago. How do you think Galileo might respond if he could view these striking images today?



NASA images of the Galilean Satellites





Now Try This

Your Own Solar System

You have learned about some astronomers who had theories about the solar system, and you have had the chance to study diagrams showing those ideas. You have learned that when Aristotle and Copernicus studied the sky, the three outer planets, Uranus, Neptune, and Pluto, had not been discovered. Through chance observations and mathematical analysis, astronomers discovered the locations of these planets and their orbit around the sun.

Create your own diagram of the solar system.



The Earth, the eight other planets, and the moon all orbit the sun.



Here's How to Do It!

Use print and online sources to find examples for your solar system. You might look in nonfiction books about the solar system or check an encyclopedia for more information. You can also find online images to help you.

Draw and color your diagram, or try using poster paper and paint. You might want to use craft supplies to make your diagram three-dimensional, or maybe you will create a mobile to hang.

Include all of the planets in your diagram. Don't forget to add the three outer ones missing from the diagrams you have seen in this book! Label each planet. Share your completed diagram with your class.





Glossary

astronomers *n.*
scientists who study
the sun, moon, stars,
planets, etc.

brilliant *adj.* shining
brightly; sparkling.

coward *n.* a person who
lacks courage or is easily
made afraid.

gleamed *v.* flashed or
beamed with light.

satellites *n.*
astronomical objects
that revolve around a
planet.

shimmering *adj.*
gleaming faintly.



Reader Response

1. Galileo used his telescope to observe the moon. Write a general statement about Galileo's observations.
2. Reread pages 4 and 5. Suppose you are a person who lived long ago. Visualize what you see in the sky. How do you explain it?
3. Look back through the book to find at least two words that were unfamiliar to you. Then reread the sections of text in which you found the words, and write a definition using context clues. Use the Glossary or a dictionary to check your definitions.

Word	Definition

4. Review the diagrams on pages 9 and 11. How did they help you understand Aristotle's and Copernicus's beliefs?

